

The Osprey And The Future Of Medium Lift

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Subject Area Aviation

Executive Summary

TITLE: THE OSPREY AND THE FUTURE OF MEDIUM LIFT

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THESIS: The tilt-rotor V-22 *Osprey* represents a remarkable increase in capability and can perform functions requiring speed and range that are well beyond the physical and aerodynamic capabilities of traditional helicopters. However, it will operate differently from current assets due to its size and non-traditional design. Given these differences, can the V-22 assume the missions assigned to the CH-46 and is the loss of capabilities sufficient to warrant a traditional medium lift helicopter to augmenting the V-22? Additionally, the V-22 is 10 years behind schedule and the CH-46 and CH-53D must continue to play a substantial role in the medium lift mission for at least the next 10 years. What is the best mix of these assets to carry out the medium lift mission until fielding of replacement aircraft is complete?

BACKGROUND: Movement of troops within the battle space is the primary role of medium lift assets. The *Osprey* represents a substantial leap in technology and capability and has the potential to transform assault support operations. However, it is wider than the CH-53E *Super Stallion*, making it the widest helicopter in the fleet. Additionally, The V-22 presents concerns for escort operations. Neither the AH-1 *Cobra*, F/A-18 *Hornet* or AV-8 *Harrier*, have the endurance to support the V-22, and thus escort support of the V-22 will require multiple sorties. Furthermore, the aerodynamic limits of external loads, generally 130 knots or less, negate the air speed benefit of the V-22 when carrying such cargo. Finally, the current production V-22 costs over \$70 million per airframe and because of its complicated design, maintenance costs are higher than expected. The Marine Corps has pursued the *Osprey* for more than twenty years and since the decision to procure the V-22 was made, new and more advanced, traditional helicopters such as the US-101 and S-92, have been developed and are currently in service around the world.

RECOMMENDATION: The V-22 will not be capable of conducting all of the medium lift missions the CH-46 has historically completed. It is time to realize the need for a new traditional medium lift aircraft to bridge the gap between the CH-46 and the V-22, and provide security to the medium lift mission. The Marine Corps must take heed of this and make efforts to preserve medium lift capability through V-22 fielding and in the future. While procurement of the best mix of assault support aircraft for the future continues, consolidation of our current assets must also occur. Sound decisions must be made on the employment of current assault support assets to maintain, to the maximum

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extent possible, the capability to move troops and equipment on the battlefield without exhausting heavy lift assets still decades from retirement. The CH-53D can provide reliable assault support to fulfill this mission.

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April 9, 2003, Baghdad, Iraq. 1st Battalion 5th Marines (1/5) conducted a raid into the city along route 2 to seize one of Saddam's palaces on the Tigris river. By dawn the following morning, 1/5 held the palace but had sustained casualties and was still receiving enemy fire. At 0630 on 10 April, a section of CH-46, *Sea Knight* helicopters launched to support casualty evacuation and resupply 1/5. The Landing Zone (LZ) designated at the palace was surrounded by 50' palm trees and just large enough for one CH-46. The LZ was receiving enemy rocket and small arms fire the ground forces were unable to suppress. The section leader directed one aircraft to land in the LZ while he provided suppressive fire. The 7.62 mm machine gun organic to the CH-46 was sufficient to quiet the enemy fire. The two helicopters reversed roles then departed the area with the wounded Marines safely aboard. Over the following 17 hours, this section flew over 11 hours, evacuated 22 souls, and provided critical ammunition resupply to 1/5. The CH-46 is due for replacement by the V-22 *Osprey* over the next 10 years, but will the V-22 provide the capabilities the CH-46 currently offers the Marines on the ground.

MCDP 1, *Warfighting*, states "in war, tactics focus on the application of combat power to defeat an enemy force in combat at a particular time and place."¹ This explains the most common use of assault support in the levels of war. During assault support operations at the tactical level, aviation employment with ground or naval forces provides mobility to the MAGTF, helps it exploit opportunities presented by the enemy or created by friendly forces, concentrates combat power rapidly at the most advantageous time and place, and helps maintain the tempo of operations and the momentum of the attack.

The tilt-rotor V-22 *Osprey* represents a remarkable increase in capability and can perform functions requiring speed and range that are well beyond the physical and aerodynamic

¹ Marine Corps Warfighting Publication (MCWP) 3-24, *Assault Support* (Washington DC: United States Marine Corps, May 2004): 1-4.

capabilities of traditional helicopters. The *Osprey's* employment will enhance the Marine Corps ability to complete assault support tasks and will modernize, if not revolutionize, assault support. The V-22 will provide the Marine Corps with an unprecedented capability to project power quickly and decisively from over-the-horizon directly onto inland objectives.²

Even though the V-22 represents a substantial leap in technology and capability, it is not without its shortcomings. The V-22 is wider than the CH-53E *Super Stallion*, making it the widest helicopter in the fleet. This will restrict access to many of the landing zones currently used by medium lift helicopters. Moreover, the performance of the V-22 in terms of speed and range presents challenges. The aerodynamic limits of external loads, generally 130 knots or less, negate the air speed benefit of the V-22 when carrying such cargo. When flying at airspeeds that exceed the stable limit of the external load, the load may be damaged or it may strike the aircraft. Even when unencumbered, range and endurance of the V-22 present concerns for escort operations. Neither the AH-1 *Cobra*, F/A-18 *Hornet* or AV-8 *Harrier*, have the endurance to support the V-22, and thus escort support of the V-22 will require multiple sorties. Finally, the high cost is an additional reason for concern. The current production V-22 costs over \$70 million per airframe, \$12 million over the forecast price. Additionally, because of its complicated design maintenance costs are higher than expected. Most troubling, when these shortcomings are viewed together, a capability gap exists between the current mainstay CH-46 *Sea Knight* and the V-22 with respect to medium lift mission support. Using a modern tilt-rotor aircraft to fill the traditional helicopter medium lift role does not ensure success in all medium lift tasks.

² Fred McCorkle, LtGen USMC, "Building Marine Aviation for the 21st Century," *Marine Corps Gazette* 83 (May 1999): 23.

Movement of troops within the battle space is the primary role of medium lift assets. The Marine Corps has pursued the *Osprey* for more than twenty years and the medium lift helicopter market has matured during this time. Since the decision to procure the V-22 was made new and more advanced, traditional helicopters have been developed and are currently in service around the world. These new helicopters can augment the V-22 and bridge the capability gap.

Even in the best-case scenario, the V-22, because of its design, will operate differently from current assets due to unique physical attributes, such as its size and non-traditional design. This begs the question of whether the V-22 can assume the missions assigned to the CH-46 and is the loss of its capabilities sufficient to drive the Marine Corps to look at augmenting V-22 capabilities?

Regardless of what assets support the medium lift mission of the future, the CH-46 and CH-53D must continue to play a role in the medium lift mission for at least the next 10 years. The *Osprey* is currently undergoing its second Operational Evaluation, and if it is successful, will begin full rate production early in 2006.³ The first squadron would receive the V-22, produced during low rate initial production (LRIP), by late 2005 and require one year to train to a combat qualified level. This squadron will require an additional 6 months to become combat capable and ready for deployment in mid 2007.⁴ Fielding all remaining squadrons will take place over the following ten years.⁵ Procurement of another aircraft, even one already in production, would take time as well. The soonest that current procurement methods could field a new helicopter would be 2009, with the first squadrons becoming combat qualified by 2010.⁶

³ V-22 completed initial Operational Evaluation in Nov 2000 but the Dec 2000 mishap forced further review.

⁴ Marine Corps Order p3500.34, *Aviation Training and Readiness Manual volume 8, tactical tilt-rotor MV-22 Pilot (T&R)*, Quantico, December 1998, 1-7.

⁵ Headquarters Marine Corps, Department of Aviation, "Marine AVPLAN," <http://hqinet001.hqmc.usmc.mil/AVN/>.

⁶ Initial training time would be less for helicopter transition than the helicopter to tilt rotor conversion.

This paper will review the V-22 project to determine what capabilities will be lost and will define the capability gap in order to determine the best mix of assault support assets to ensure the complete coverage of medium lift missions in the future. Additionally, this paper will determine the best mix of current assets to carry out the medium lift mission until fielding of replacement aircraft is complete.

HMM MISSION ASSETS

The primary function of the Marine Medium Helicopter Squadron (HMM) is the movement of troops within the area of operation. By employing assault support operations judiciously, the commander can take full advantage of fleeting opportunities throughout the battle space. Speed and focus of effort are essential elements of maneuver, both of which the MAGTF commander can apply using assault support. This ability to concentrate forces rapidly is a hallmark of naval expeditionary power projection. Mobility and flexibility, gained by extensive use of assault support aircraft in tactical operations, are an important part of the Marine aviation doctrine. Improved aircraft design has increased the combat radius and load capacity of assault support aircraft, providing more flexibility and fire support to the MAGTF.⁷

Medium lift assets must be able to rapidly move troops and high mobility multipurpose wheeled vehicles (HMMWV) close to hostile action to rapidly build combat power. This section will introduce platforms capable of conducting this mission, both those currently in use and those new to this arena. It will also look at utility and heavy lift platforms currently employed by the Marine Corps to better understand all options available to fulfill this mission, understand their interrelationship and the opportunity costs involved.

The aircraft we will examine include veteran performers, such as the CH-46 *Sea Knight*, CH-53D/E *Sea/Super Stallion*, UH-1 *Iroquois*, and UH-60 *Black Hawk*, and newcomers such as the Boeing Bell V-22 *Osprey*, the Sikorsky S-92 *Super Hawk*, Lockheed Martin-AugustaWestland, Bell Textron US-101 and the European Aeronautic Defense and Space (EADS) Northrop Grumman NH90. Table 1 compares the capabilities of these aircraft.

⁷ Marine Corps Warfighting Publication (MCWP) 3-24, *Assault Support* (Washington DC: United States Marine Corps, May 2004): 1-1.

VETERANS

The Marine Corps has been moving Marines by helicopter for over 50 years and for nearly 40 of those the CH-46, CH-53, and UH-1 have been primary players. These aircraft were the stalwart of assault support in Vietnam and have participated in virtually every conflict since.

Additionally, though not flown by the Marine Corps, the UH-60 has amassed an equally impressive record. These venerable workhorses have proven their importance as assault support platforms.

CH-46 E *Sea Knight*



The Boeing CH-46 *Sea Knight* is a twin turbine powered, dual piloted, tandem rotor, medium helicopter designed to operate in adverse conditions day or night. It was first introduced into the Marine Corps in 1964. The CH-46E has

seats for 22 passengers and can accommodate 15 litters; however, degradation limits the useful load to 8-12 depending on environmental conditions. The *Sea Knight* can cruise at 145 knots, has 2.0-hour endurance and a range of 132 nautical miles, and is armed with two 7.62 mm or .50 caliber machineguns in the crew door and window. A gross aircraft weight of 24,300 pounds provides a useful load of 5,000.⁸ While the CH-46 has undergone several improvements in its life span, it still struggles to meet basic performance parameters.⁹ The V-22 is planned to replace the CH-46 between fiscal year 2006-2015.¹⁰

⁸ Headquarters Marine Corps, Department of Aviation, Aircraft information page, <http://hqinet001.hqmc.usmc.mil/AVN/>.

⁹ David W Coffman, Capt USMC, "21st century medium lift: The CH-46 in the 1998-2005 timeframe," *Marine Corps Gazette* 78, (May 1994): 42.

¹⁰ Anonymous, "Marine aircraft," *Sea Power* (Jan 2004): 7.

CH 53 D *Sea Stallion*



The Sikorsky CH-53D *Sea Stallion* is a twine turbine, dual piloted, traditional main/tail rotor, medium/heavy helicopter designed to operate in adverse conditions day or night. It was first introduced into the Marine Corps in 1966 and is a more capable version of the CH-53A.¹¹ The CH-53D is equipped

with 28 crash attenuating seats; however, it is administratively limited to 24 passengers.¹² It can cruise at 130 knots, has 5.5-hour endurance and a 600 nautical range, and is armed with two XM 218 .50 caliber machineguns. A gross aircraft weight of 42,000 pounds provides a useful load of 10,000 pounds. Forty airframes still exist and are stationed at Kaneohe Bay, Hawaii, with eight of those aircraft supporting unit deployment program in Iwakuni Japan. The V-22 is planned to replace the CH-53D in fiscal year 2012-2013.¹³

CH-53 E *Super Stallion*



The CH-53E *Super Stallion* is a three-engine, dual piloted, traditional main/tail rotor heavy helicopter designed to operate in adverse conditions day or night. It was first introduced into the Marine Corps in June 1981 and is a more capable version of the

CH-53D. The *Super Stallion* can accommodate up to 55 passengers; however, it is administratively limited to 24.¹⁴ It can cruise at 150 knots and has 5.0-hour endurance and a 540 nautical range, and is armed with two XM 218 .50 caliber machineguns and a ramp mounted weapon. Aerial refueling and in-flight servicing of hydraulic and lubrication systems can extend

¹¹ Headquarters Marine Corps, Department of Aviation, <http://hqinet001.hqmc.usmc.mil/AVN/>.

¹² MEU and senior level commanders have waver authority on the 24-pax restrictions.

¹³ Anonymous, "Marine aircraft," *Sea Power* (Jan 2004): 8.

¹⁴ MEU and senior level commanders have waver authority on the 24-pax restrictions.

aircraft endurance to crew limits or to the 25-hour engine inspection cycle.¹⁵ A gross aircraft weight of 73,500 pounds provides a useful load of 32,000 pounds. The *Super Stallion* is the largest helicopter in the U.S. inventory and is the only helicopter that can lift the 155mm howitzer, its crew, and ammunition.¹⁶ The CH-53E will be replaced by the CH-53X in the 2020 period.

UH-1 N/Y *Iroquois*



The Bell UH-1Y *Iroquois* “Huey” is a twin turbine powered, dual piloted, traditional main/tail rotor utility helicopter designed to operate in adverse conditions day or night. The UH-1Y is an upgraded version of the UH-1N first introduced into the Marine

Corps in 1971. The UH-1Y *Iroquois* has seats for 10 passengers, can cruise at 135 knots, and has 3.0-hour endurance and a range of 260 nautical miles.¹⁷ The Huey is armed with crew served machineguns or fixed forward firing ordinance. The aircraft’s gross weight of 18,500 pounds provides a useful load of over 6,000 pounds. The Marine Corps is upgrading 100 of its 1970’s era UH-1Ns to UH-1Y tactical utility helicopter over the next several years. New four-bladed composite, main and tail rotor systems are the most noticeable changes that have been made.¹⁸

¹⁵ Headquarters Marine Corps, Department of Aviation, <http://hqinet001.hqmc.usmc.mil/AVN/>.

¹⁶ United Technologies, Sikorsky, “CH-53E Information page” http://www.sikorsky.com/details/0,3036,CLI1_DIV69_ETI265,00.html.

¹⁷ Air force technology, “Specifications - UH-1Y Huey Utility Helicopter,” http://www.airforce-technology.com/projects/uh_1y/specs.html.

¹⁸ Textron, Bell Helicopter, “UH-1 information sheet,” <http://www.bellhelicopter.textron.com/en/aircraft/military/bellUH-1Y.cfm>.

UH-60 *Black Hawk*



The Sikorsky UH-60 *Black Hawk* is a twin turbine, dual piloted, main/tail rotor utility helicopter designed to operate in adverse conditions day or night. It was first introduced into U.S. forces in 1978. The UH 60 has seats for 11 passengers.

The *Black Hawk* can cruise at 160 knots, has 3.1-hour endurance and a range of 350 nautical miles. A gross aircraft weight of 22,000 pounds provides a useful load of 8,000 lb.¹⁹ An External Stores Support System (ESSS), consisting of removable four-station pylons, multiplies *Black Hawk* roles. With the ESSS, the UH-60 can carry additional fuel tanks for self-deployment up to 1,150 nautical miles or fire munitions to include Hell Fire.²⁰ Derivatives include: electronic warfare, special operations, executive transport, U.S. Air Force *Pave Hawk*, U.S. Navy *Sea Hawk* and U.S. Coast Guard *Jay Hawk*.

NEWCOMERS

The V-22 has dominated the medium lift replacement competition since it was chosen as the successor to the CH-46 in 1981. The UH-60 challenged the *Osprey* at the onset of the procurement process but was never a serious competitor. The times have changed however, with new additions to the medium lift market. Sikorsky's S-92 *Super Hawk*, US-101, and the NH90 all have emerged as medium lift competitors.

¹⁹ Naval Warfare Publication 55-9, *CH-46E Tactical Manual*.

²⁰ United Technologies, Sikorsky, "Black Hawk Information page" http://www.sikorsky.com/details/0,3036,CLI1_DIV69_ETI254,00.html.

MV-22B *Osprey*



The V-22 *Osprey* is a twin engine, dual piloted, tilt-rotor aircraft designed to operate over long distances without a runway in austere to all-weather environment day or night. The V-22 is expected to begin full rate production in 2006. The *Osprey* can carry 24 troops and cruises at 250 knots, has 2.0-8.0 hour

endurance and a range of 430-2,100 nautical miles.²¹ A gross aircraft's weight of 52,600 pounds provides a useful load of over 10,000 pounds.²² The V-22 combines the vertical takeoff and landing characteristics of a helicopter with the speed and range of a turboprop aircraft, and was developed to fulfill multi-service operational requirements.²³ It is the world's first production tilt-rotor aircraft and incorporates advanced technologies in composite materials, digital avionics, fly-by-wire controls, and survivability. The V-22 is planned to replace the CH-46 and CH-53D over the next 10 years.

S 92 *Super Hawks*



The Sikorsky S-92 *Super Hawk* is a twin turbine powered, dual piloted, traditional main/tail rotor medium helicopter designed to operate in austere to all-weather environment day or night. First flown in 1998, the *Super Hawk* is based on proven *Black Hawk* technology. *Super Hawk* can carry 22

²¹ The V-22 range and endurance data vary configuration and type of operations.

²² Headquarters Marine Corps, Department of Aviation, <http://hqinet001.hqmc.usmc.mil/AVN/>.

²³ Department of Defense, Office of the Inspector General, "V-22 Osprey Hydraulic System (D-2002-114)," (June 24 2002): 8.

troops and cruises at 150 knots, has 4.0-hour endurance and a range of 500 nautical miles.²⁴ A gross aircraft weight of 28,000 pounds provides a useful load of over 10,000 pounds. Mission flexibility and low operating costs were primary design criteria that result in this high performance, versatile helicopter that is safe and economical.²⁵

NH 90



The European Aeronautic Defense and Space (EADS), North America Northrop Grumman NH 90 *Tactical Transport Helicopter (TTH)* is a twin turbine powered, dual piloted, traditional main/tail rotor medium helicopter designed to operate in austere to all-weather environment day or night. First flown in December 2003, the *TTH* can carry 20

troops, cruises at 140 knots, has 4.5-hour endurance, and a range of 450 nautical miles.²⁶ The aircraft's gross weight of 23,370 pounds provides a useful load of over 5,500 pounds. The HN90 is the first production fly-by-wire helicopter, and deliveries are expected in 2005.²⁷ Eleven countries have ordered more than 345 airframes.²⁸

US 101



The US-101 is a three engine, dual piloted, traditional main/tail rotor medium helicopter designed to operate in austere to all-weather environment day or night. The US-101 is the Lockheed Martin AugustaWestland variant of the

²⁴ Air force technology, "H-92 SuperHawk Multi-Mission Helicopter," http://www.airforce-technology.com/projects/uh_1y/specs.html.

²⁵ United Technologies, Sikorsky, "H-92 Super Hawk Information page" http://www.sikorsky.com/details/0,3036,CL11_DIV69_ETI1583,00.html

²⁶ Air force technology, "NH90 NFH ASW/Transport Helicopter," <http://www.airforce-technology.com/projects/hn90/specs.html>

²⁷ Graham Warwick, "Rotary Options," *Flight International*, 166 (Aug 17 2004): 34.

²⁸ NHI Industries, "The NH90 TTH (Tactical Transport Helicopter) Information Page," <http://www.nhindustries.com/site/FO/scripts/siteFO>.

European EH-101 first flown 1998. The US-101 will carry 30 troops and cruises at 150 knots, has 7.0-hour endurance and a range of 750 nautical miles.²⁹ A gross aircraft weight of 34,400 pounds provides a useful load of over 14,000 pounds. It will be produced at a Bell Textron facility in the US. Since 1998, 95 EH-101 operational aircraft have proven to be readily adaptable to a wide range of missions, from troop transport to search and rescue, and from executive transport to anti-surface and anti-submarine warfare. Variants of the EH 101 platform have logged more than 55,000 flying hours worldwide.³⁰

²⁹ Air force technology, "EH101 Utility Helicopter," <http://www.airforce-chnology.com/projects/eh101/specs.html>.

³⁰ Lockheed Martin, AgustaWestland, Bell Helicopter, "Multi-Mission Flexibility," <http://www.teamus101.com/444.cfm>.

Table 1

Size and Capability Comparison

	Functional Lift, lbs	Passenger	Range Naut miles	Endurance	A i r Speed	W i d t h	L e n g t h	A i r Refuel	C o s t
CH-46 E	5,000	9-16	135	2:00	145	51' 0"	84' 4"	No	N/A
CH-53 D	10,000	28	600	5:30	130	72' 3"	88' 6 "	No	N/A
UH-60 M	9,000	11	350	3:05	160	53' 8"	64' 10"	Yes	\$ 9 mil*
MV-22 B	10,000	24	430	2-8:00	250	84' 6"	57' 4"	Yes	\$74 mil
US-101	14,000	30	750	7:00	150	61' 0"	63' 1"	Yes	\$44 Mil
S-92	10,000	22	500	4:00	153	56' 4"	68' 6"	Yes	\$14 Mil
NH-90	5,500	20	430	4:30	140	53' 5"	64' 2"	Yes	\$25 Mil
CH-53 E	32,000	33-55	540	5:00	150	79' 0"	99' 5"	Yes	\$40 Mil*
UH-1 Y	6,6000	10	260	3:20	135	48' 11"	57' 4"	No	N/A
*Cost in 1997 dollars. All others 2004 V-22 Range and endurance dependant on configuration and type of operations Information compiled from: Jane's all the words aircraft 2004-05, HQMC, Department of Aviation, aircraft information, and Manufacture information.									

OSPREY CAPABILITIES

Helicopters are inherently inefficient and lack range, driving a requirement to devise a vehicle that is faster, has more range, and is more cost effective than conventional helicopters. “Assault support missions that cover large distances and that require vertical takeoffs and landings have challenged aeronautical pioneers since helicopters first proved their worth more than 50 years ago. Within this challenge, the Joint Services specified in detail the operational requirements of the V-22. This requirement defined missions, airframe size constraints, payload handling, and other operational capabilities required to meet the needs of all the U.S. military. The V-22 *Osprey* is a revolutionary change. It has been cited by the Department of Defense (DoD) as a truly transformational system. It brings capabilities not found in any helicopter – twice the speed, three times the payload and five times the range of the legacy helicopters that it replaces.”³¹

The V-22 program started in December 1981 and was managed by the Army until it was transferred to the Navy in December 1982. In 1986, the Navy obtained approval to enter into the Full-Scale Development phase and awarded a contract to Bell-Boeing to design and produce six aircraft for flight and ground testing. The first flight of the V-22 took place in March 1989.

The office of the Secretary of Defense canceled the program in December 1989, and this action spurred the Institute for Defense Analysis to conduct a Cost and Operational Effectiveness Analysis (COEA) of seven possible V-22 alternatives. This study found the V-22 to be the most economical alternative, and Congress forced over \$600 million into the FY 1991 budget for V-22

³¹ Textron, Bell Helicopter, “The V-22, Transforming Aviation: Capabilities Extended, Options Multiplied, Missions Redefined,” <http://www.bellhelicopter.com/en/aircraft/military/bellV-22.cfm>.

research and development. The DoD had not requested any funding for the V-22 that year. Nor did DoD request funding for the V-22 in 1992, but once again Congress insisted.

In October 1992, the Navy entered the Engineering and Manufacturing Development (EMD) phase, awarding Bell-Boeing an EMD contract for four preproduction V-22 aircraft. In an April 1997 Acquisition Decision Memorandum, the USD (AT&L) approved the Marine Corps variant of the V-22 to enter the Low-Rate Initial Production (LRIP) phase. Between April 1997 and August 2003, 10 LRIP aircraft (#11-20) were built and accepted into the V-22 Program.³² Table 2 shows significant events in the V-22 time line.

During its first operational evaluation (OPEVAL), 6 November 1999 through July 2000, the V-22 demonstrated that it could carry 24 combat-equipped Marines or a 10,000-pound load, achieve true airspeed of 248 knots, and travel 2,113 nautical miles with a single aerial refueling. On November 17, 2000, the Director of Operational Test and Evaluation concluded that the V-22 was operationally effective but not operationally suitable. The Director stated that the V-22 “demonstrated marginal mission reliability.” The Director’s conclusion that the V-22 was not operationally suitable was based on maintenance shortcomings and specifically on the failure rates related to the hydraulic system experienced during the OPEVAL.³³ However, this ruling was sufficient to move the program into full rate production. The December 2000 mishap involving a LRIP V-22 that killed four Marines removed this consideration, as the program was put on hold and flight operations stopped pending a full investigation. Flight-testing resumed in May 2002.

Some of the capabilities that will make the V-22 an indispensable part of the MAGTF are:

³² Geoff S Fein, “Upcoming Osprey flight tests are do-or-die,” *National Defense* 88 (Aug 2004): 36.

³³ Department of Defense, Office of the Inspector General, “V-22 Osprey Hydraulic System” (24 June 2002): 8.

Aerial Refueling

Employment of either aerial refueling or rapid ground refueling (RGR) provides the means to extend the range of aircraft, equipment, and personnel. Access to fuel increases the combat radius or time on station of aviation assets. These options available to the commander have a positive effect on friendly morale and destroy enemy morale. The MAGTF commander should exploit the psychological effect that aviation has on both friendly and enemy forces.³⁴

The Osprey's ability to aerial refuel increases its own capability and allows it to position fuel forward in the battle space for RGR or Forward Arming and Refueling Point (FARP) operations. This allows for refueling of light and attack helicopters and ground vehicles. While not yet developed, the V-22 will also enhance mobility as a tanker, moving fuel to other aerial refueled aircraft such as the CH-53E and AV-8.

Speed

With a cruise speed of 240 knots, the Osprey displays the inherent values of a tilt rotor concept. Traditional helicopters are limited in forward air speed by advance and blade stall, the phenomenon in which the blade on the advancing side of the rotor disc approaches Mach-1 and stalls. With its nacelles tilted forward, the Osprey negates this effect by flying like a turboprop aircraft. The V-22 realizes better than a 50 percent increase in speed from a traditional helicopter, 240 knots as compared to 150 knots for a traditional helicopter.

Range

Not only do rotating nacelles allow for faster operation but also allow the V-22 to cruise at altitudes far beyond those achievable by traditional helicopters. This allows the V-22 to operate as a fixed wing turbo-prop aircraft and take advantage of more fuel-efficient operations at altitudes up to 25,000 feet as compared to 10,000 feet maximum altitude for non-pressurized

³⁴ Marine Corps Warfighting Publication (MCWP) 3-24, *Assault Support* (Washington DC: United States Marine Corps, May 2004): 1-5.

helicopter operations. The combination of speed and the associated increase in range result in the most dramatic differences that set the V-22 apart from its traditional relatives. It is capable of transiting 2100 nautical miles with a single aerial refueling, nearly twice what the most capable traditional helicopter can accomplish. The V-22 can do this in 9 hours, 5 hours less than traditional rotorcraft. The full advantage of V-22 speed and range are best realized on long distance missions and diminish as mission radius decreases. In operations with less than a 75 nautical mile radius, the advantages are negligible.³⁵

Self-Deployment

With a cargo capability of up to 10,000 pounds and the ability to re-fuel in flight, the V-22 squadron has the ability to deploy to any area in the traditional Marine Corp expeditionary role. Approximately half the squadron's aircraft would be required to move personnel allowing the remaining half to move parts, supply equipment and tools, while some additional lift will be required for oversized support equipment. Less than one C-17 would be required to move a V-22 Squadron compared to 12 C-17s required to move a CH-46 Squadron. The V-22 possesses the capability to get to the crisis area and be ready to accept missions the same day. This is a substantial force multiplier, when compared to the delay involved with traditional cargo aircraft transportation. The tear down, load up, rebuild and test sequence involved with transporting helicopters aboard strategic lift aircraft can take weeks to provide an operational squadron to a conflict. Additionally, this gives the V-22 the ability to conduct small scale, rapid and decisive distributive operations as directed anywhere in the world.

Survivability

The V-22 can use its advantages of speed and altitude to defeat enemy weapons systems in ways traditional helicopters cannot. Flying at up to 25,000 feet above ground level (AGL), the V-22

³⁵ Gregg Skinner, Maj USMC, USMC, Aviation Plans, and Policy, assault support division, Interview (27 Jan 2005).

can transit above the envelope of man portable surface to air missiles (ManPads). The aircraft has incorporated composites to deflect heat and engine suppressors to reduce the aircraft's IR signature. Additionally a lightweight paint designed to give the V-22 an unprecedented level of reduced IR signature is used on this aircraft at a cost of \$7,000 per gallon.³⁶ Furthermore, the V-22 was designed with sophisticated counter measures, ballistic tolerant materials, and redundant, well-placed systems for increased survivability. While the aircraft does not yet have a self-defense weapon, the M3M ramp-mounted .50 cal and the M240G 7.62 mm machine gun are options being considered.³⁷ Finally, any helicopter hovering in a landing zone regardless of the amount of high tech countermeasures, is equally vulnerable to shoulder fired rockets. While the *Osprey* has many features to improve survivability, the following section will discuss what concerns exist with these systems, specifically during helicopter operations.

Externals

The ability to externally carry loads of up to 10,000 pounds is a substantial increase in the capability over the CH-46 and is similar to that of the CH-53D. This will allow more flexibility to the MAGTF commander and reduce the workload on the CH-53E. It must be noted that external loads cannot travel at speeds the V-22 is capable of. These loads and the speed at which they can travel are listed in the *Multi-Service Helicopter Sling Load: Dual-Point Load Rigging Procedures*.³⁸ The maximum airspeed for stable flight of an external load varies depending on the aerodynamic characteristics of the load but generally falls between 80-130 knots. Flying outside of the established envelope, the load can generate its own lift, oscillate, or bounce.

³⁶ Geoff S Fein, "Upcoming Osprey flight tests are do-or-die," *National Defense* 88 (Aug 2004): 36.

³⁷ Richard Burgess, "V-22 Osprey Team Focuses on January Operational Evaluation," *Sea Power*, 47 (Apr 2004): 32.

³⁸ MCRP 4-23 E, *Multi-Service Helicopter Sling Load Manuals VOL III*.

Attempting to exceed the established airspeed limit can damage the load or worse the aircraft carrying it.

Speed, range, and the ability to conduct aerial refueling allow for the self-deployment of the V-22 to any crisis. The ability to move personnel and equipment allows the MAGTF Commander to exploit opportunities in his AO. The survivability of the V-22 allows it to function in the hostile areas where these missions must take place. This combination of capabilities makes the V-22 well suited to support the fly in echelon of the MEB or to conduct rapid and tactical operations with global reach.

Table 2
V-22 time line

Date	Event		note
Dec 1981	V-22 Program started	Managed by the Army	1
Dec 1982	Program transferred to the Navy		1
1986	Full-Scale Development aproved	6 aircraft for flight and ground testing	1
Mar 1989	First flight		1
Apr 1989	Sec Def Cheney denounced the V-22	Congressional testimony	
Dec 1989	Office of Sec Def Cancels V-22 program		
Oct 1992	Entered Engineering and Manufacturing Development (EMD)	4 pre production V-22	1
13 Dec 1994	Passed critical design review		2
April 25, 1997	Low-Rate Initial Production (LRIP) approved	10 LRIP delivered as of jun 2002	1
Nov 1999 -Jul 2000	Operational evaluation		1
30 Apr 1999	First LRIP A/C flight	USMC accepted A/C 14 May 1999	2
8 Apr 2000	Mishap in Arizona	19 Marines killed	2
November 17, 2000	V-22 deemed operationally effective not operationally suitable.	Due to marginal mission reliability.	1
December 11, 2000	V-22 crashed in Jacksonville, NC it had logged only 157.7	Four Marines killed LRIP Buno #165440	1
December 12, 2000.	Flight operations suspended		1
May 29, 2002	Flight-testing resumed.		1
Jun 1999	VMMT 204 activated VMMT-204 in June 1999 as the MV-22B training squadron	First flight	
Aug 2003	VMX-22 activated	Operational Test and Evaluation Squadron	
1 Department of Defense, Office of the Inspector General V-22 Osprey Hydraulic System (D-2002-114) June 24, 2002 2 Janes all the worlds aircraft 2004-05			

OSPREY CONCERNS

While the V-22 is an exceptional aircraft that has the potential to transform assault support, it is still not fielded and the program is wrought with problems. The program has been on the brink of cancellation, suffered set backs, and is now more than 10 years behind schedule. Some of the specific concerns include:

Reliability

The V-22 has suffered four mishaps from June 1991 through December 2000 resulting in the loss of 30 Marines and crewmen and 4 aircraft. EMD aircraft mishaps occurred in June 1991 when flight control wiring problems caused the destruction of an aircraft and in July 1992 when an engine oil fire and subsequent driveshaft failure caused the aircraft to crash in the Potomac River killing all 7 crewman. On 8 April 2000, an additional 19 Marines were killed in Yuma Arizona aboard a LRIP V-22 that experienced vortex ring state.³⁹ On 11 December 2000, a second LRIP V-22 crashed in Jacksonville, North Carolina, during a routine training mission. This mishap resulted from a hydraulic line failure and flight control system software anomaly that occurred when the pilot pressed the flight control reset button. All four Marines aboard were killed and the aircraft was lost. As a result of the December 2000 mishap, the Commandant of the Marine Corps and NAVAIR jointly suspended V-22 flight operations on 12 December 2000.⁴⁰ This mishap also identified a substantial problem with the hydraulic lines in the engine nacelles of the V-22. Table 3 shows mean time between failure (MTBF) rates as projected by Bell-Boeing and as observed in EMD, Opeval, and VMMT 2004 aircraft.

³⁹ Vortex ring state is an aerodynamic phenomenon that occurs at high rates of decent. The aircraft settles in the downwash from the rotors and the rotor system stalls.

⁴⁰ Department of Defense, Office of the Inspector General, "V-22 Osprey Hydraulic System" (24 June 2002): 8.

The V-22 has suffered from lesser problems as well. In April 2004, a 20-inch portion of a prop-rotor blade departed the aircraft during de-icing tests in Nova Scotia. During final shipboard trials, a nacelle blower failed and now requires replacement on 100-hour intervals. The final Opeval scheduled for February 2005 was delayed when the gearbox that drives the prop-rotor produced metallic fragments indicative of internal failure. Replacement of the gearboxes on multiple aircraft required a substantial maintenance effort.

Table 3. V-22 Hydraulic System Reliability Rates (MTBF)⁴¹

Predicted			Measured		
Hydraulic subsystem			EMD	OPEVAL	VMMT-204
	60,000 FH	2,000 FH	1,581.1 FH	804.5 FH	569.1 FH
HYD-1	445	268	83(exp)	67	19
Lines	1,219	762	99	81	24
HYD-2	445	268	83	73	21
Lines	1,263	789	132	89	26
HYD-3	373	225	83	67	32
Lines	755	472	113	115	38

Maintainability

The reliability issues have a substantial impact on maintenance. Issues, such as the failed nacelle blower, require shortened replacement cycles and increase the maintenance man-hour per flight hour (MMH/FH) requirement. The December 2000 mishap sighted chafing of hydraulic lines as a causal factor. The mishap aircraft had logged only 157.7 flight hours at the time, and the mishap report concluded that the rigid common hydraulic line made of thin-walled titanium in the left nacelle ruptured because the line chafed on a wire harness. The Report also stated that a VMMT-204 inspection of hydraulic lines found chafing conditions on all eight LRIP aircraft.

⁴¹ Department of Defense, Office of the Inspector General, "V-22 Osprey Hydraulic System" (24 June 2002): 14.

This caused substantial rework of the hydraulic line in the nacelle at an additional maintenance cost. The MTBF rate displayed in table 3 shows a much higher failure rate than predicted. More importantly, the failure rates for production aircraft are higher than those for the EMD aircraft. The higher failure rate requires proportionally more maintenance to the aircraft. Additionally, incidents like the re-routing of hydraulic lines and the replacement of faulty prop-rotor gearboxes, cause substantial one-time spikes in the maintenance man hour requirement. The increase in maintenance is troublesome for the V-22 program, as reducing maintenance cost was a significant selling point for the program.

Escort

Threat levels determine assault support feasibility. There are three general threat levels: low, medium, and high. There is no clear division between these threat levels; air defense systems that present a low or medium threat level for one aircraft type may present a high threat level for another aircraft type. A medium threat level during daylight hours may be a low threat level at night.⁴²

The purpose of an escort is to destroy, neutralize, or suppress a threat before it is able to influence the assault support mission. This is accomplished in one of three ways: Attached Escort provides visual weapons coverage and responsive fires for threat engagement during medium to high threat conditions. Detached Escort provides reconnaissance and selected coverage at predetermined sites en route in low to medium threat levels. Detached escort aircraft provide protection by clearing a path for the assault force. Combined Escort, attached and detached escort techniques combined, provides a defense in-depth, horizontally and vertically, and around the assault support aircraft. Although providing the best all-around protection for the

⁴² Marine Corps Warfighting Publication (MCWP) 3-24, *Assault Support* (Washington DC: United States Marine Corps, May 2004): 2-3.

assault support flight in all threat levels, combined escort is costly because it requires more assets than the other escort techniques.⁴³ Due to the range and endurance of the V-22, any existing escort will require multiple sorties or refueling of fixed wing escorts enroute. While much has been discussed regarding the difficulties of escorting the V-22, these issues are associated with escort of the CH-53E as well. When the threat dictates the requirement for escort, it will be completed as required. However, due to the distance covered more assets will be needed. Fixed wing assets will be required for en route escort either attached or detached. FARP operations and forward deployed rotary wing escort can also be used, but they complicate the evolution and give indications of the mission objective area before the assault flight arrives.

Self Defense Weapon

Much effort went into development of the V-22 survivability systems, and its technology, speed and altitude are important aspects. However, any helicopter in the LZ or in a hover is susceptible to many enemy threats. Shoulder fired weapons, for instance, can be employed before escort aircraft can prosecute them. The best defense from this threat is a self-defense weapon, typically a door gun. While self-defense weapons for the V-22 are being developed, two large problems exist in the form of the nacelles. Having the engines rotated vertically at the 3 and 9 o'clock, positions creates a problem for the Crew Chief and Gunner, for even when a weapon is installed, it will be difficult to acquire targets behind the nacelle and virtually impossible to engage them. During Operation Iraqi freedom, CH-46 aircraft used their organic weapons to suppress enemy fire and allow other aircraft in their flight to enter the LZ, delivering ammunition and evacuating wounded Marines. The V-22 as fielded will not be capable of conducting this mission.

⁴³ Marine Corps Warfighting Publication (MCWP) 3-24, *Assault Support* (Washington DC: United States Marine Corps, May 2004): 2-6.

Size

With a greater width than the mighty CH-53E, the V-22 will not fit into the traditional landing zones (LZ) of the medium lift helicopter. Tactical troop movements into hostile environments will be limited to the LZ's more than 100' wide that can accommodate the V-22. The size of the V-22 will have substantial impact on how well it can accomplish the traditional medium lift mission. This specific concern with the V-22 has no resolution other than using smaller aircraft to augment its mission. The UH-1Y will provide improved lift capabilities as compared to the UH-1N but with only 10 seats it will not be able to support rapid build up of combat power. Some other asset must be sourced to resolve this situation.

Cost

"Our greatest fiscal challenge is balancing the expenditure of finite resources for current readiness and legacy programs with the imperative of accelerating modernization programs and long-term readiness."⁴⁴ The V-22 is by far the most expensive assault support aircraft ever developed. The per aircraft cost of Lot 6 production in 2004 was \$74 million.⁴⁵ The Marine Corps hopes to reach the target cost of \$58 million per aircraft, but Lot 9 low rate production aircraft are budgeted at \$68.9 million.⁴⁶ The solution may be as simple as Commandant Jones stated in Dec 2000: "If the service is not successful in reducing costs, then what's going to happen is that we are going to buy fewer V-22s. And what are we going to do? Are we going to keep CH-46s flying? No, I want to go to a museum and see a CH-46, that's where it belongs."⁴⁷

While multiple cost analyses studies were completed in the mid 1990s, and all indicated an

⁴⁴ Fred McCorkle, LtGen USMC, "Building Marine aviation for the 21st century," *Marine Corps Gazette* 83 (May 1999): 23.

⁴⁵ Richard R Burgess, "V -22 Osprey Team Focuses on January Operational Evaluation," *Sea Power*, 47 (Apr 2004):. 32.

⁴⁶ Geoff S Fein, "Upcoming Osprey flight tests are do-or-die," *National Defense*, 88 (Aug 2004): 36.

⁴⁷ Linda de France, "MV-22 'ready for prime-time,' Marine Commandant says," *Aerospace Daily*, 43 (Dec 1, 2000): 37.

economic benefit to a single aircraft V-22 medium lift fleet, the situation continues to change. The procurement and operational and maintenance cost of the V-22 continue to rise above the level forecasted in these studies. Furthermore, development test and evaluation (DT&E) cost of new medium lift helicopters are reduced as new systems are fielded. As other services and other countries procure and field these new helicopters, they must complete their own DT&E, reducing the burden on subsequent procurement. As these trends continue, the cost effectiveness of an all V-22 fleet decreases. With the purchase by the US Navy of the US-101, the US military will now own a new traditional medium lift helicopter. Additionally, the Air Force is looking to purchase 130 medium size helicopters for its personnel recovery vehicle (PRV) fleet to replace its fleet of HH-60G and UH-1Ns. As more traditional medium lift helicopters enter service, the development and per unit cost will continue to fall, thereby decreasing cost benefit of a single aircraft medium lift fleet.

Primary Aircraft Authorized (PAA)⁴⁸

The PAA of a V-22 squadron once fielded is slated to be 12. Replacing a 12-plane CH 46 squadron with an equal number of much more capable aircraft results in an overall increase in total capability. Given the capability of the V-22, this increase in squadron capability would be somewhat more than double the current lift. Why does the Marine Corps need to double its medium lift capability? Even if the PAA was reduced to 10, 10 V-22s would still double the capability of a 12-plane CH-46 squadron, assuming 10-passenger capability for the CH 46. Reducing the PAA by 2 aircraft over 15 Squadrons could save \$ 1.74 billion.⁴⁹

⁴⁸ PAA is the number of aircraft assigned to a particular squadron.

⁴⁹ Geoff S Fein, "Upcoming Osprey flight tests are do-or-die," *National Defense*, 88 (Aug 2004): 36. 30 A/C @ \$58 mil per A/C

Unknowns

While many capabilities of the V-22 have been validated and some concerns have been identified, the V-22 is still under evaluation and we do not know what we do not know. The V-22 has had its share of problems, but what is next. Given the current short fall in medium lift, manifestation of unforeseen problems could prove critical. As with all new aircraft, we can expect situations similar to the AV-8 and CH-53E that were down fleet wide for systemic aircraft problem. Known as a “Red Strip,” this situation grounds the entire type/model/series fleet.⁵⁰ What will be the effect on the medium lift fleet when the V-22 goes down? How will the V-22 handle helicopter operations at high altitude? What will be the effect on the airframe of extended operation in dusty environments? Will the intense exhaust from the nacelle affect landing on certain types of surfaces or present a hazard to personnel on the ground? Will the V-22 present a “Roll on deck” situation in an austere or urban situation. While TTPs are being developed to properly employ the V-22, these will need to be revised and adjusted as the aircraft matures.

While all new aircraft suffer mishaps and have uncertainties that must be overcome, few have undergone the scrutiny the *Osprey* has endured. These concerns are not life threatening to the V-22 program, but they do indicate a need for a more traditional, supplemental medium lift to ensure mission success over the next 20 years.

⁵⁰ “Red Stripe” is a NavAir message regarding the downing of an entire type/model/series of aircraft.

A POTENTIALLY BETTER MIX

The V-22 has the potential to revolutionize assault support operations, but it is still struggling to prove its worth and is not a one-for-one replacement for its predecessor the CH-46. The previous section noted some shortcomings in the V-22, and collectively these shortcomings indicate a gap between the capability of the V-22 and CH-46. While the V-22 has not been fully tested, the size of this capability gap may increase. This section will focus on the shortcomings currently known and the impact theses have on the *Osprey's* ability to conduct the medium lift mission.

Size alone limits V-22 ability to conduct the CH-46 mission. The lack of a self-defense weapon, extended operations in austere and dusty environments, and adverse effects from the direct downward exhaust from the nacelles could further restrict the V-22 from additional tasks and widen the capability gap. Specifically, this gap will be exacerbated in the 2015 period when the V-22 fielding is nearing completion, the CH-53E is at the end of its service life, and the last of the traditional medium lift helicopters are retired. To maintain the traditional capabilities provided by the CH-46, the V-22 will need to be augmented.

The argument against a mixed medium lift fleet has centered on cost; it is simply more expensive to maintain multiple aircraft. However, the cost of losing capabilities is immeasurable. Moreover, while multiple studies conducted in the 1990s have shown the economic benefits of an all V-22 fleet, the passage of time and the fielding of new medium lift helicopters is changing this data. The cost of the V-22 both in per unit purchase and maintenance terms continues to increase. Conversely, the cost associated with traditional medium lift helicopters continues to decrease, as other countries and other services procure these new machines in larger numbers. As both of these cost trends continue, the economic benefit of

an all-V-22 fleet is diminished. It is prudent to maintain diversity in the medium lift fleet, and traditional medium lift helicopters have seen substantial increase in technology and a consequent reduction in maintenance cost. As the cost benefit of the all *Osprey* fleet approach zero, the reasons for not augmenting are eliminated.

One scenario that might highlight the V-22 capability gap is operating in restrictive terrain, such as jungle or urban areas. The tight terrain provides the enemy with cover and concealment near the landing zone and affords an excellent opportunity to employ RPGs. The lack of a self-defense weapon and the restrictions to observation and fire created by the nacelles if a weapon is employed from the cabin create vulnerability for the V-22 in this environment. Furthermore, the large size degrades maneuverability in tight terrain, and engine exhaust presents hazard.

While the V-22 is well suited for long-range operations, benefits of the V-22 decrease as distance and time requirements decrease. For operations with less than a 75 nautical mile radius, the value added by the V-22 is minimal.⁵¹ The HMLA squadrons with a 125 nautical mile combat radius limit the range of the ACE.⁵² Although extended in range by the current and ongoing upgrades they are still not in-flight refuelable and will force the ACE closer to the operating area or require FARP operations to maintain their capabilities. The range of the V-22 gives it the ability to fly away from the rest of the ACE. Furthermore, we must look at the types of missions that assault support aircraft are currently conducting. In Iraq, for instance, most medium lift missions were 10-75 nautical miles.⁵³ The CH-46 has been employed successfully there in a multitude of missions, all of which have been in its range capabilities.

⁵¹ Gregg Skinner, Maj USMC, USMC, Aviation Plans, and Policy, assault support division, Interview (27 Jan 2005).

⁵² AH-1Z Combat radius

⁵³ D. Presto, Maj USMC, Command and Staff Collage, Interview (8 Mar 2005).

In addition to any capability gap, we can expect that the *Osprey* will continue to struggle with the initial problems that plague all new aircraft. All aircraft experience design flaws and deficiencies after fielding. The CH-53E was down for an extended period with swash plate and tail disconnect problems. The AV-8 suffered from engine bearing issues. Similar circumstances surround the fielding of virtually all military aircraft. The V-22 can expect fleet wide grounding during its fielding, as all new aircraft have experienced. Within a “neck down” strategy, this can be substantially more troublesome.⁵⁴ Given the age of the current helicopter fleet, a mechanical shortcoming that would down the entire V-22 fleet could paralyze assault support operations. Unlike the CH-53E and the AV-8, the *Osprey* will have little in the way of back up to support its mission in a “Red Stripe” situation. While CH-53Ds and CH-46s supported the CH-53E mission and the F/A-18 supported the AV 8 mission during troubled times in the early fielding of these aircraft, the aging CH-53 E is already out pacing its life cycle, and the UH-1Y will not have the lift capability to conduct the medium lift mission. Shortfalls created with the downing of the full fleet of V-22s compounded by the age of the CH-53E will be insurmountable without some alternative medium lift.

Given these problems, it may look as if the V-22 is too far ahead of its time. It may appear that the best option for today may be to abandon the V-22 and employ a traditional replacement for the CH-46, or to delay the whole of the V-22 program until the technology can be better employed. However, this would be a critical and shortsighted error. The V-22 has current capabilities that will substantially enhance assault support and these must be fostered and cultivated, as the V-22 represents technological changes that are critical to the future of assault support. It is the first substantial developmental change in vertical landing rotorcraft since the

⁵⁴ “Neck down” refers to the current trend to use few types aircraft with a wider and more general capability to assume the mission of several types of more specialized aircraft.

development of the swash plate.⁵⁵ The best situation for complete coverage of all capabilities and appropriate investment in the future is a mixed fleet of V-22 and traditional medium lift helicopters.

What should the Marine Corps use to augment the V-22 and assure reliable assault support lift across the full spectrum of missions? Section two described several new medium lift helicopters that may fill this role, all of which are capable of supporting this mission. The Air Force is retiring its HH-60G Pave Hawks and looking to purchase approximately 130 new aircraft in its Personnel Recovery Vehicle (PRV) program. The Air Force is expected to release a request for proposal for its PRV program this March, and the helicopter market is ready to respond. Competitors for the PRV are expected to include the EADS North America-Northrop Grumman NH-90 helicopter, the Lockheed Martin-AgustaWestland-Bell Textron US-101 helicopter, the Sikorsky S-92 helicopter, and the Bell-Boeing CV-22 *Osprey* tiltrotor aircraft.⁵⁶ Like all helicopters, the traditional competitors cannot compete with the V-22 with respect to range or speed, as inherent limitations with traditional helicopters prevent this. However, improvements in these traditional systems have reduced maintenance requirements and provide a proven traditional performer. The decision on which helicopter should augment the V-22 is not a difficult one. Cost will drive a large part of this decision, and Air force procurement will make the platform it selects much more economically viable in the acquisition system. The mission requirements should be tied to the ground mission and include the capability to lift the HMMWV and rapidly build-up combat power in LZs similar in size to those used by the CH-46. Because of helicopter range and payload limitations, the ability to refuel in flight will also be required to support future operations including STOM.

⁵⁵ Developed in the 1930, the swash plate transfers control inputs to the moving rotor blades

⁵⁶ Marc Selinger, "USAF delays draft RFP for Personnel Recovery Vehicle," [*Aerospace Daily & Defense Report*](#), 213 ([Jan 28, 2005](#)): 2

The Navy will have an all H-60 helicopter fleet by 2012 with the purchase of 243 MH-60R and 273 MH-60S. The Army is updating its H-60 force, remanufacturing its H-60A to H-60M and purchasing an additional 300 of this aircraft.⁵⁷ If the H-60 is still good for the Army and Navy, can it be the right answer for the Marine Corps? A January 1991 study on the effectiveness of tilt rotor support to the ground combatant by Lawrence Livermore National Laboratory identified the substantial benefit of a V-22 fleet over a mixture of H-60 and CH-53E fleet. This study showed the benefits of the V-22 over different sortie mixes, different ranges and highlighted the fact that the H-60 is simply too small to fulfill the Marine Corps medium lift mission.⁵⁸ The H-60 has marginal ability to lift a HMMWV and its 11 seats are insufficient to rapidly build combat power.

Both in 1993 and again in 2002 during times when the V-22 project was in jeopardy not sound, the Marine Corps identified potential replacements. Among those aircraft examined were the Sikorsky S-92 and European helicopter EH-101.⁵⁹ The other option that exists and is included in the PRV discussions is the NH 90. Both the S-92 and NH 90 yield a total lift advantage to the *Osprey* but both are substantially larger than the H-60 and are functional medium lift helicopters. The NH90 is the smallest of these competitors with a nominal payload of 5500 pounds and capacity for 20 combat equipped troops. While it can marginally manage only a stripped down HMMWV, it can move nearly twice as many troops as the H-60. As the smallest and least capable of these helicopters, it would be third on the list of options as the V-22 augment. The S-92 with its 10,000-pound payload can more easily handle a HMMWV and seats 22 troops. While larger than the NH90 and capable of supporting the medium lift mission, it is

⁵⁷ Graham Warwick, "Rotary Options," *Flight International*, 166 (Aug 17 2004): 34.

⁵⁸ A.S. Warshawsky, D.U. Olness, *Effectiveness of tilt rotor support to Ground combat*, Lawrence Livermore National Laboratory, (Jan 1991)

⁵⁹ Marc Selinger, "DoD studying V-22 alternatives, but not B-2 production, Aldridge," [*Aerospace Daily & Defense Report*](#), 201 ([Mar 14, 2002](#)): 1.

not the best option to augment the V-22. The US-101 has substantial lift capabilities and, with 30 seats, can handle 6 more troops than the V-22. The US-101 helicopter is similar in capabilities to the CH-53D. With a 14,000-pound capacity, it can lift all variants of the HMMWV with the associated crew.⁶⁰

The Navy has recently agreed to purchase 23 US-101 helicopters for the HMX-1 executive lift mission, and some say that decision will influence Air Force decisions in the PRV program.⁶¹ If the Air Force and the Navy combine to purchase the US-101, the per-unit cost will continue to fall as the total number purchased increases. This will increase the economic feasibility of a mixed fleet. Aside from cost, the US-101 is the most useful helicopter for the Marine Corps mission. Its size being only 10 feet wider than the CH-46 allows it access to nearly all the LZs the CH-46 could use. Moreover, the ability to lift 7 tons will reduce the burden on the CH-53E for small external operations.

Regardless of which alternative is chosen to augment the V-22, the fielding that would best support the new traditional aircraft would also need to be decided. Given the capabilities of the V-22 and those of the US-101, a 2/3 V-22, 1/3 US-101 mix would best suit the fleet. Six to eight squadrons of the US-101 would be fielded, two squadrons per wing with an additional two as an option in the reserve. With a PAA of 10 Aircraft per squadron, a projection of 60 aircraft would be needed for fleet operations. With 12 aircraft in the FRS and 12 for replacement and SDLM cycles, a total purchase of 84-104 aircraft would be required. An associated reduction of 72-100 V-22s from the 6-8 squadrons would be required. Using current data, \$2.8 billion

⁶⁰ MCRP 4-23 E, *Multi-Service Helicopter Sling Load Manuals VOL III*.

⁶¹ Robert Wall, "Sea change" *Aviation week& Space Technologies*, 6, (7 Feb 2005): 40.

surplus would be created. The surplus would likely be greater as the per-unit cost of the augment aircraft will fall as total procurement increases.⁶²

⁶² \$44 mil / US 101 and \$72 mil / V-22 and a 100 a/c trade off. greater surplus is S-92 of NH 90 were selected.

ASSAULT SUPPORT THROUGH FIELDING

Even if the *Osprey* passes all aspects of the operational evaluation currently underway, it will not be fielded until 2006. Fielding to replace all 15 CH 46 squadrons and all three CH-53D squadrons will span an additional ten years. If an augment to the V-22 were chosen, the earliest possible fielding would be 2009. The legacy aircraft will need to continue their mission for the foreseeable future, and far beyond, if the *Osprey* does not fare well in the operational evaluation.

The Marine Corps will be forced to make the most of existing assets to support this mission through 2015. The CH-46 is severely limited at altitude but able to maneuver in small LZs, as its work in Iraq has shown. The limited lift capability of CH-46 is placing an increased burden on the ageing CH-53Es with its 6500-hour airframe. The CH-53E can move troops with great success but comes at the expense of heavy lift sorties in other areas and take time off this aging airframe. The CH-53D has been sequestered in Hawaii since 1996, and while it has recently rejoined the West Pac UDP cycle, supply issues have plagued it and given it a stigma of obsolescence. However, the CH-53D has a substantial capability as a proven troop mover and can reduce the burden on the CH-53E in high altitude and external operations.

The Current State of Medium Lift Assault Support

The CH-46 is currently capable of lifting 8-12 combat ready marines at sea level and is practically useless at altitudes above 7,000 feet. While the most capable aircraft will be retained while the *Osprey* is fielded, allowing the Marine Corps to scrap the oldest and least capable aircraft, the general capability of the CH-46 is limited. The CH-46 has gone through several modifications to maintain this capability over its history to include Survivability, Reliability and Maintainability (SR&M) in the 1980s and the on going Engine Reliability Improvement Program (ERIP). However, no amount of stopgap fixes can make up for the 40-year-old airframe. While

upgraded in 1978, the airframe still shows scars of the Vietnam War with its bullet hole patches. While upgrades have extended the service life to 12,500 hours, the oldest of these aircraft will begin to reach that plateau this year.⁶³

The CH-53D, the other medium lift helicopter, has been reduced substantially in numbers with the fielding of the CH-53E in the 1980s. Due in part to this reduction, only the most capable CH-53D airframes remain in the fleet. The CH-53D has been sequestered in Hawaii since 1996, but the aircraft retains a substantial amount of its design capabilities. It is still capable of moving 24+ troops above 7,000 feet with moderate reduction in range. The CH-53D community has been on the sidelines since these aircraft were consolidated in Hawaii. The UDP re-start in 2001 reenergized the community, but supply issues caused by atrophy of an under-used system limits the capabilities and the deployment of these units. Despite these limitations, the CH-53D has succeeded in supporting the UDP program and in so doing so has increased its visibility. This has lead to increased role for the CH-53D. Recently CH-53Ds have seen service with the 31st MEU, 1stMAW unit development program, and humanitarian relief operations in Indonesia. The forty aircraft still operating are divided into three ten plane squadrons with the remaining aircraft either in scheduled depot level maintenance cycles or kept at the squadron as a PAA overage. The CH-53D does not have the heavy lift capability that the CH-53E has but does possess at least two to three and a half times the lift of the CH-46. Furthermore, it can and maintain this capability at altitude. Unlike the CH-53E, the CH-53D participates in helicopter insertion and extraction operations regularly making this aircraft an excellent troop mover. Moreover, the CH-53D is equipped with the AN/ALQ-157 infrared missile countermeasure and due to the lower temperatures of its two engines, it is considerably more survivable than the three

⁶³ David W Coffman, Capt USMC, "21st century medium lift: The CH-46 in the 1998-2005 timeframe," *Marine Corps Gazette*, 78, (May 1994): 42.

engine CH-53E. The CH-53D is still a capable and relevant asset but needs funding for spare parts. The CH-53E is a very capable platform, but it is the only heavy lift helicopter available to the MAGTF and will remain as such for the next 10-15 years. Continued use of the CH-53E in the medium lift role will thus have a significant impact on the future capability. Additionally the CH-53E is by far the most maintenance intensive helicopter, requiring more than 40 MMH/FH this makes the CH-53E very costly to fly.

The best use of the legacy airframes

While the CH-46 will continue to function in its limited capacity until the final airframe is parked in the “bone yard”, there are better options to increase the troop lift capability within the MAGTF and reduce the work load on the CH-53E. The CH-53D is the best medium lift platform in the inventory. As stated, the CH-46 on any given day can carry 8-12 combat ready troops. The CH-53D is administratively limited to 24 but possesses the capability to lift 28 passengers. Therefore, the CH-53D has three times the lift of the CH-46 in the same conditions. Furthermore, the CH-53D maintains its ability to lift these troops above 7,000 feet MSL. Some trade off in fuel is required, but the mission and the capability are preserved. Maintenance man-hours per flight hour for the two aircraft are similar, and the squadron size is proportionate to the amount of aircraft in the squadron. The 12 aircraft CH-46 squadron has approximately 20 percent more people than the 10 aircraft CH-53D squadron. However, considering the CH-53D can move three times the payload of the CH-46, that much more mission is accomplished per maintenance man hours. The end state is movement of passengers and cargo at 1/3 the cost, in terms of maintenance effort, as movement by CH-46. Furthermore, the lift created by the three ten-plane CH-53D squadrons is greater than half of the entire CH-46 fleet and gives 1st MAW a

greater medium lift capability than either 2nd or 3rd MAW.⁶⁴ Along this same line, a four-plane CH-53D detachment can move the same amount as a full 12 plane CH-46 squadron. When considered in this light, the three CH-53D squadrons can do the work of seven CH-46 squadrons with respect to moving Marines, can do this mission with substantially greater range and endurance, and can maintain their capability at altitude. Troop movement mission in Afghanistan has almost been completely taken over by the CH-53E due to the altitudes involved. Additionally, any external operations in any theatre are relegated to the CH-53E. While the CH-53E is more than capable of conducting these missions, one must consider the opportunity cost involved. Life cycle of the CH-53E is 6,500 hours, some airframes have already reached this mark, and more are moving towards it at an alarming rate. If the CH-53E is forced to continue conducting missions that other platforms can complete, it will reach its life cycle well ahead of its programmed replacement time. The CH-53X heavy lift upgrade to the CH-53E is now being discussed but will not be fielded before 2015-2021.⁶⁵ The capability that the CH-53E brings to the MAGTF Commander is a substantial one, and it must be preserved to the maximum extent possible. The CH-53D can provide relief to the CH-53E.

The usefulness of the CH-53D to small task forces is high. As an example, let us look at a situation in which a platoon sized rapid reaction force is must be capable of helicopter operations. Five CH-46s would be required to move 36 Marines and a detachment of seven aircraft would be required to ensure availability of 5 given 75 percent reliability. Using the CH-53D in this situation two aircraft would move the 36 Marines and a 3 aircraft detachment would

⁶⁴ 15 squadrons X 12 plans X 8pax =1440 pax 3 X 10 X 24 =720pax

⁶⁵ Headquarters Marine Corps, Department of Aviation, *AVN Brain book*, <http://hqinet001.hqmc.usmc.mil/AVN/>, (Nov 2004): 15.

ensure availability. This represents a savings of four C-17 sorties assuming strategic air lift is required.

The CH-53D is the best troop mover in the Marine Corps and is capable of moving external loads in excess of 10,000 pounds. The capabilities of this airframe need to be optimized and utilized to reduce the burden on the CH-53E and maintain a viable medium life asset during the V-22 fielding. The CH-53D fleet must be provided with required parts and supply and employed worldwide to maintain the capability expected from the medium lift community until the V-22 can assume its full role.

CONCLUSIONS

The V-22 is a truly revolutionary aircraft and over the next 20 years should prove to open up capabilities not yet imagined. The *Osprey* will provide the Marine Corps with technology to unlock an unprecedented capability. With attack variants and quad tilt rotor variants, the Marine Corps of the future can be truly capable of full-scale Ship-To-Objective Maneuver. However, as the CH-46 and CH-53D continue to age, the V-22 is still undergoing its final operational evaluation.

Previous new procurement aircraft have had their share of mishaps and shortcomings after fielding, and if the V-22 follows suit, the Marine Corps will not have assets to support the medium lift mission while its problems are corrected. The V-22 will not be capable of conducting all of the medium lift missions the CH-46 has historically completed. It is time to realize the need for a new traditional medium lift aircraft to bridge the gap between the CH-46 and the V-22, and provide security to the medium lift fleet. The Marine Corps must take heed of this and make efforts to preserve medium lift capability through fielding and in the future.

Advancements in traditional rotorcraft and the fielding of new medium lift helicopters are driving down the DT&E and per unit cost of traditional assault support. As the cost of the V-22 continues to raise both in per unit terms and in maintenance requirements, the added cost of maintaining a mixed fleet diminishes. It is now prudent to procure traditional, proven and reliable helicopters to support this mission.

While we strive to procure the best mix of assault support aircraft for the future, we must consolidate our current assets and make the sound decisions on their employment to maintain, to the maximum extent possible, the capability to move troops on the battlefield without exhausting

heavy lift assets still decades from retirement. The CH-53D can provide reliable assault support to fulfill this mission.

BIBLIOGRAPHY

Air force technology. "EH101 Utility Helicopter," <http://www.airforce-chnology.com/projects/eh101/specs.html>.

Air force technology. "NH90 NFH ASW/Transport Helicopter." <http://www.airforce-technology.com/projects/hn90/specs.html>.

Air force technology. "Specifications - UH-1Y Huey Utility Helicopter." http://www.airforce-technology.com/projects/uh_1y/specs.html.

Air force technology. "H-92 SuperHawk Multi-Mission Helicopter." http://www.airforce-technology.com/projects/uh_1y/specs.html.

Anonymous. "Marine aircraft." *Sea Power*. (Jan 2004): 7.

Anonymous. "Osprey enters production phase." *Manufacturing engerning.133* (Aug 2003): 23.

Boeing Rotorcraft. "V-22 information page." <http://www.boeing.com/rotorcraft/military/v22/flash.html>

Bonholtzer, Craig and Suzanne. "Super Stallion: Mission to Afghanistan." *Rotor and Wing*. (March 2002): 17.

Burgess, Richard. "V-22 Osprey Team Focuses on January Operational Evaluation." *Sea Power*. 47 (Apr 2004): 32.

Coffman, David W, Capt USMC. "21st century medium lift: The CH-46 in the 1998-2005 timeframe." *Marine Corps Gazette* 78. (May 1994): 42.

De France, Linda. "MV-22 'ready for prime-time,' Marine Commandant says." *Aerospace Daily*. 43 (Dec 1, 2000): 337.

Department of Defense. Office of the Inspector General. "V-22 Osprey Hydraulic System (D-2002-114)." (June 24 2002): 8.

Doyel, Andrew. "Eurocopter studies NH90 civil variant." *Flight international* 166. (Oct 5, 2004): 24.

Fein, Geoff S. "Upcoming Osprey flight tests are do-or-die." *National Defense*. 88 (Aug 2004): 36.

Gamelin, John J. MAJ, USMC, *The MV-22 Osprey; Changing the face of assault support*. MMS Thesis. Quantico, VA: U.S. Marine Corps Command and Staff College, April 2002.

Hanifen, Timothy G. Maj USMC. "V-22: There Is No Alternative." *Marine Corps Gazette* 79, no. 5 (May 1995): 34.

Headquarters Marine Corps, Department of Aviation, <http://hqinet001.hqmc.usmc.mil/AVN/>.

Jackson, Paul. *All the Worlds Aircraft 2004-05*. Jane's information Group. Alexandria VA. (Nov 2003)

Lockheed Martin, AgustaWestland, Bell Helicopter. "Multi-Mission Flexibility."
<http://www.teamus101.com/444.cfm>.

Marine Corps Order p3500.34. *Aviation Training and Readiness Manual volume 8, tactical tilt-rotor MV-22 Pilot (T&R)*. Quantico, December 1998. 1-7

Marine Corps Warfighting Publication (MCWP) 3-24. *Assault Support* (Washington DC: United States Marine Corps. (May 2004): 1-4.

McCorkle, Fred, LtGen USMC. "Building Marine aviation for the 21st century." *Marine Corps Gazette* 83 (May 1999): 23.

McGraw-Hill. "United States." *Overhaul and Maintenance*. 8 (Nov 2002): 64.

MCRP 4-23 E, *Multi-Service Helicopter Sling Load Manuals VOL III*.

Naval Warfare Publication 55-9. *CH-46E Tactical Manual*, Vol. 1. (Washington, DC: Department of the Navy and Marine Corps, May 1995).

NHI Industries. "The NH90 TTH (Tactical Transport Helicopter) Information Page."
<http://www.nhindustries.com/site/FO/scripts/siteFO>.

Philips business information. "V-22 Replacement Not on Table, Commandant Says." *Helicopter News* 27 (22 Mar 2001): 1.

Presto, D. Maj USMC, Command and Staff Collage, Interview (8 Mar 2005).

Siniff, Dean, T. MAJ, USMC, *MV-22 Osprey Transition: Bridging the Gap in Medium Lift Assault Support*. MMS Thesis. Quantico, VA: U.S. Marine Corps Command and Staff College, April 1999.

Skinner, Gregg Maj USMC. HQMC, Aviation Plans, and Policy, assault support division, Interview (27 Jan 2005)

Sullivan, Martin J. Seymour, Christopher C. "The Osprey: Reviewed, renewed, transformed." *Marine Corps Gazette* 87. ([May 2003](#)): 32.

Textron, Bell Helicopter. "UH-1 information sheet." <http://www.bellhelicopter.textron.com/en/aircraft/military/bellUH-1Y.cfm>.

Textron, Bell Helicopter. "The V-22, Transforming Aviation: Capabilities Extended, Options Multiplied, Missions Redefined." <http://www.bellhelicopter.com/en/aircraft/military/bellV-22.cfm>.

Selinger, Marc. "DoD studying V-22 alternatives, but not B-2 production, Aldridge," [*Aerospace Daily & Defense Report*](#). 201 (Mar 14, 2002): 1.

Selinger, Marc. "USAF delays draft RFP for Personnel Recovery Vehicle." [*Aerospace Daily & Defense Report*](#). 213 ([Jan 28, 2005](#)): 2.

Selinger, Marc. "V-22 program fine-tuning de-icing methods." [*Aerospace Daily & Defense Report*](#). 212 (Dec 1, 2004): 3.

United Technologies, Sikorsky. "CH-53E Information page." http://www.sikorsky.com/details/0,3036,CLI1_DIV69_ETI265,00.html.

United Technologies, Sikorsky. "Black Hawk Information page." http://www.sikorsky.com/details/0,3036,CLI1_DIV69_ETI254,00.html.

United Technologies, Sikorsky. "H-92 Super Hawk Information page." http://www.sikorsky.com/details/0,3036,CLI1_DIV69_ETI1583,00.html.

Navy, NAVAIR. "V22 Osprey Web." <http://pma275.navair.navy.mil/index.cfm>

Wall, Robert. "Great Expectations." *Aviation week & Space Technologies* 22. (Dec 6, 2004): 32.

Wall, Robert. "Sea change." *Aviation week & Space Technologies*. 6, (Feb 7, 2005): 40.

Warshawsky, A.S., Olness, D.U. *Effectiveness of tilt rotor support to Ground combat*, Lawrence Livermore National Laboratory. (Jan 1991).

Warwick, Graham. "Rotary Options." *Flight International*, 166 (Aug 17, 2004): 34.